N-63-4-3

FORWARDED BY THE CHIEF, BUREAU OF SHIPS.

MONTHLY STATUS LETTER NO. 10

DEVELOPMENT OF LOW NOISE TRAVELING-WAVE TUBES
Phase III.: Environmentalization

This Report Covers the Period 1 November 1962 to 1 December 1962

MICROWAVE ELECTRONICS CORPORATION
4061 Transport Street
Palo Alto, California

Submitted A C Ashley
A. C. Ashley
Project Engineer

Approved H W Frerking
H. Frerking
Manager of Engineering

Navy Department Bureau of Ships, Electronics Division
Contract NObsr-81227, Index Number SS-021001/S.T. 21
Contract Date: 2 February 1961, Modification 4, Date: 26 January 1962

NOTICES

In order to more clearly differentiate between the tubes developed during the previous phases of this contract and the environmentalized tubes being developed during this phase of the contract, new tube type numbers have been assigned to the subject tubes.

TABLE I

Tube Conversion Numbers

Band	Old Number	New Number
L	M2115	M5056
S	M2110	M5057
C	M2109	M5058
X	M2108	M5059

ABSTRACT

Temperature tests were made on three M5057 tubes during the reporting period. Results varied from quite good on one tube to poor on another. The inconsistency of operation continues to be a problem.

Package parts for ten M5057 and ten M5059 tubes have been ordered. It is anticipated that no major package changes will be required to complete the M5057 and M5059 environmentalization.

CONTENTS

ILLUSTRATIONS

1. PURPOSE

1.1 The purpose of this phase of NObsr-81227 is to environmentalize, in accordance with Class 2 requirements of MIL-E-5400E(ASG), the tubes developed under the previous phases of this contract.

1.2 The detailed objectives of this contract are the following.

1.2.1 Environmentalize tubes in order to operate under the following conditions.

Shock: 15 g
Temperature: -54C to 71C
Altitude: 70,000 feet
Vibration: 5 to 55 cps, 0.06 double amplitude

1.2.2 Perform evaluations on two tubes each of X-, C-, S-, and L-bands, as follows.

Complete environmental tests
Temperature
Shock
Vibration
Life test to 1000 hours minimum

1.2.3 Present electrical, mechanical, and environmental specifications in MIL-E-1 format for each of X-, C-, S-, and L-bands for reliable performance in military electronic systems.

1.2.4 Deliver two each of X-, C-, S-, and L-band tubes which meet the objective specifications under this phase (III) of the contract, and which also meet the original objective specifications of the contract.

2. PROGRESS DURING THE REPORTING PERIOD

2.1 Summary

Effort during the reporting period has been directed toward the environmentalization of the M5056, M5057, and M5059 tube types and toward the manufacture of parts for ten each of the M5057 and M5059. Major emphasis was placed on the environmentalization of the M5057.

2.2 M5056 Environmentalization

2.2.1 The effort on the M5056 has been directed toward obtaining the proper focusing characteristics. The test results for the M5057 and M5059 (Monthly Status Letter Nos. 7 and 8) have indicated the need to obtain all beam focusing magnetically, instead of through a combination of magnetic and electric fields. The proper focusing characteristics have not as yet been obtained with the M5056.

2.2.1.1 A review of the operation of the M2115 indicates that proper PPM-focusing was not achieved with that tube. Focusing was adequate for operation at room ambient temperature and for limited temperature ranges, but was not satisfactory for MIL-E-5400, Class 2, operation.

2.3 M5057 Environmentalization

2.3.1 Three tubes, M5057, Serials 4, 5, and 6, were temperature tested during the reporting period, and all were qualified successes.

2.3.1.1 M5057, Serial 4, gave the best temperature performance which has yet been achieved. However, the test verified a mechanical problem which had been suspected on earlier tubes: the RTV potting compound was causing the vacuum envelope to be pulled out of position in the package as the RTV elongated during temperature cycling.

2.3.1.2 M5057, Serial 5, had the vacuum envelope potted into the package using Stycast 2850FT. The use of the Stycast seemed to be satisfactory as far as retaining the vacuum envelope in the proper position. Unfortunately, the electrical performance of this tube was not as good as M5057, Serial 4.

2.3.1.3 Tube M5057, Serial 6, has given the best broadband noise figure performance yet achieved at MEC for a PPM-focused TWT. This performance is a direct benefit of the results which have been obtained through the work on the magnetic circuit. However, this tube did not perform as well as M5057, Serial 4, during temperature test.

2.3.2 Manufacture has been started on ten sets of package parts for the M5057. Although the environmentalization of the tube is not quite complete, it is anticipated that any further package modifications will be of a minor nature.

2.4 M5058 Environmentalization

2.4.1 The completion of the preliminary design of the M5058 and the ordering of parts for three packages was to have been completed during the reporting period. However, in the course of reviewing the design of the M5058 package, it was decided to modify the design in order to use pin matches.

2.4.1.1 The size, weight, and performance limitations of the cavity match presently used on the M2109 and M2112, and the good pin matches obtained on the M5057, M2216, and other MEC TWT's, indicate that it would be better to make the M5058 using pin matches rather than cavity matches.

2.4.1.2 The preliminary design for the M5058 using pin matches is almost complete. Parts for vacuum envelopes and packages should be ordered during the next reporting period.

2.5 M5059 Environmentalization

2.5.1 The effort on the M5059 during the reporting period has mainly been toward repeating the test results of the M5059, Serial 1, in the preliminary package configuration. The focusing characteristics of this tube have not as yet been repeated, either with M5059, Serial 1, or with combinations of other packages and vacuum envelopes. It is thought that the problem is one related solely to the magnetic circuit.

2.5.2 Manufacture has been started on ten sets of package parts for the M5059. Although the environmentalization is not complete, it is anticipated that any further package modifications will be of a minor nature.

3. OPERATIONAL RESULTS

3.1 M5057 Environmentalization

3.1.1 The temperature test results of M5057, Serial 4, are given in Fig. 1. Although these results are quite good, the test must be considered a failure due to the mechanical movement of the vacuum envelope inside the package.

3.1.2 M5057, Serial 5, was packaged to be as nearly the same as M5057, Serial 4, as possible. One measure of sameness between the two tubes is the relative dependency of helix current upon helix voltage. A comparison of helix currents as a function of helix voltage at different temperatures is given in Fig. 2.

3.1.2.1 The dependency of the helix current upon helix voltage was greater with M5057, Serial 5, than with M5057, Serial 4. The direct bearing of helix current and voltage on temperature performance can be seen if Fig. 3 is compared with Fig. 1.

3.1.3 Performance of M5057, Serial 6, was intermediate between the M5057 Serials 4 and 5. Helix current was essentially independent of helix voltage over a wide range of voltage (Fig. 4). The temperature test performance for noise figure and power output was satisfactory, but small-signal gain changed more than expected.

3.1.3.1 A measurement of fine structure at -75C and at +125C showed that the match was changing with temperature. The amount of change could possibly account for the change in gain (Fig. 5). Measurement of test frequencies was not accurate enough to confirm or deny the possibility.

3.1.3.2 Upon completion of the temperature test, the tube was vibrated. The small-signal gain showed 1.0 db AM at 0.060 DA and

TEMPERATURE TEST PERFORMANCE, M5057, SERIAL 4

Data Taken at 3.0 Gc
Data Plotted Relative to Performance at 25C
Small-Signal Gain = 37.0 db
Power Output = 14.5 dbm
Noise Figure = 9.0 db

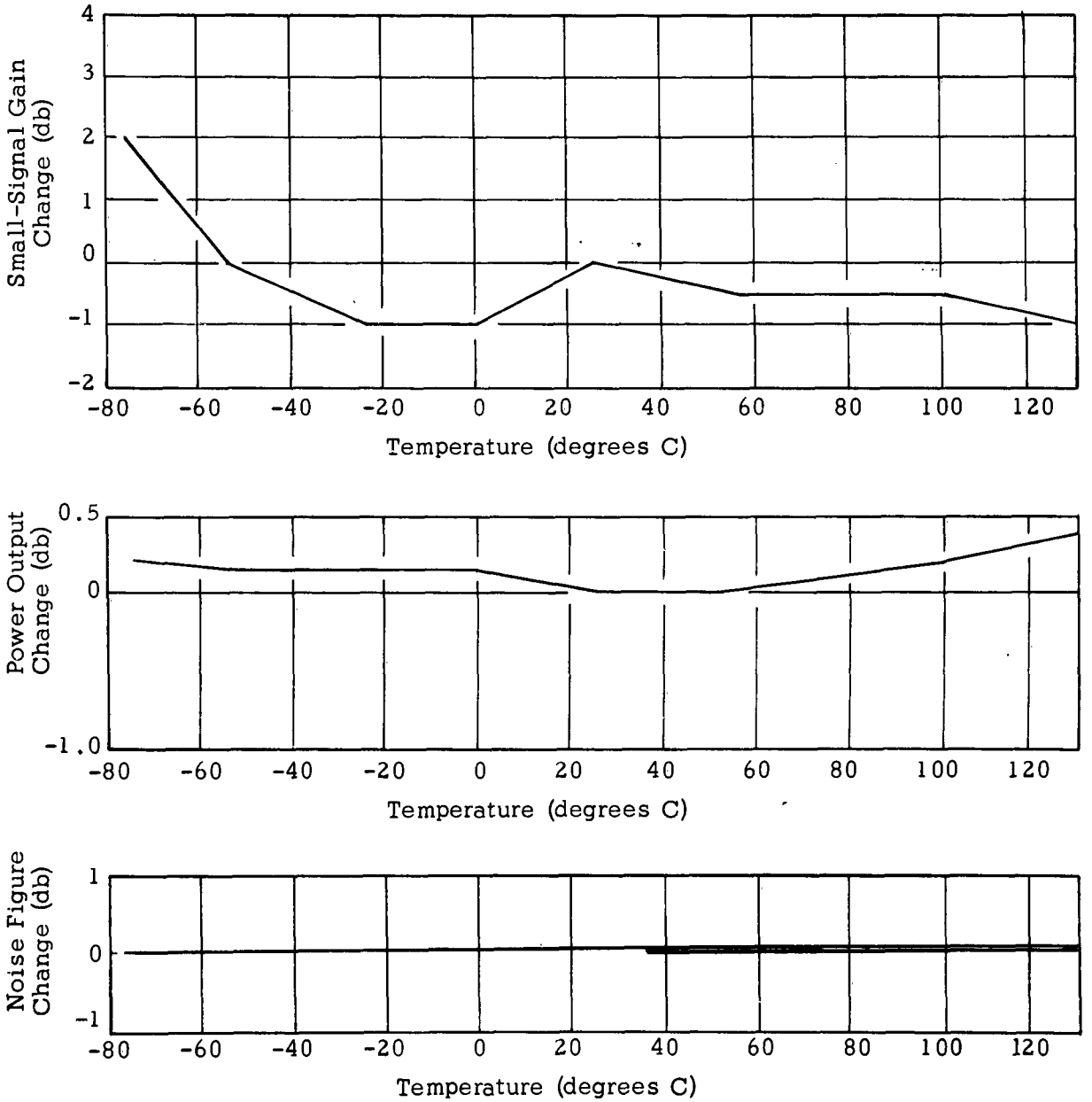


Fig. 1. Temperature Test Performance, M5057, Serial 4.

HELIX CURRENT VERSUS HELIX VOLTAGE, M5057, SERIAL 4

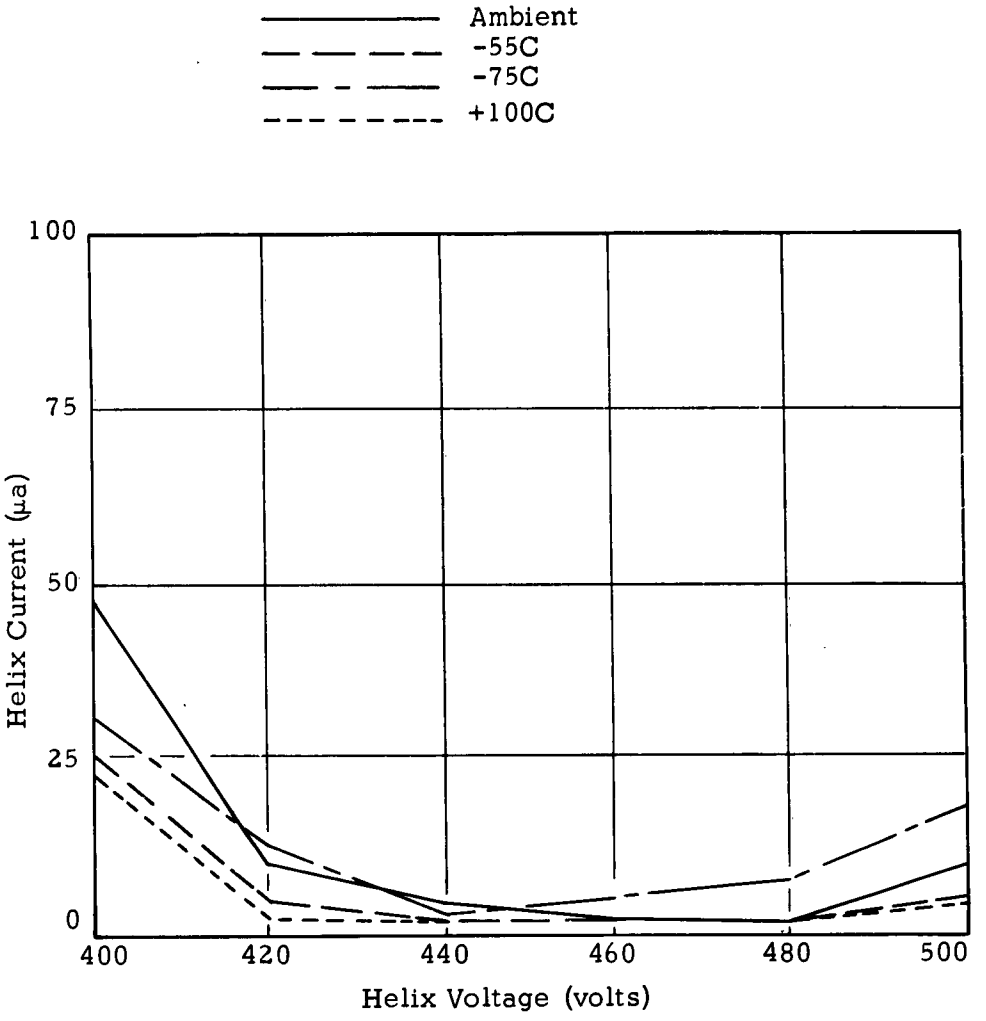


Fig. 2.1 Helix Current Versus Helix Voltage, M5057, Serial 4.

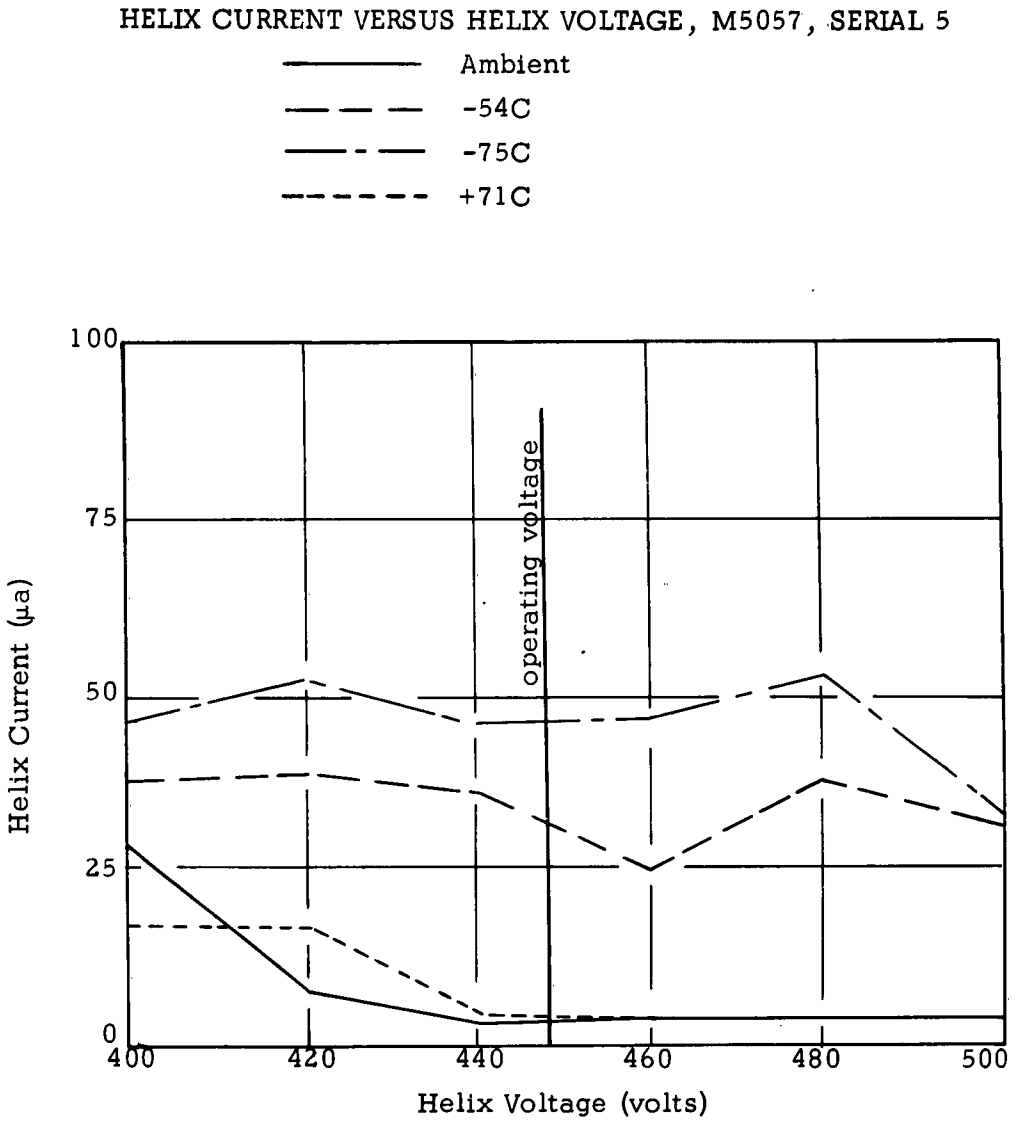
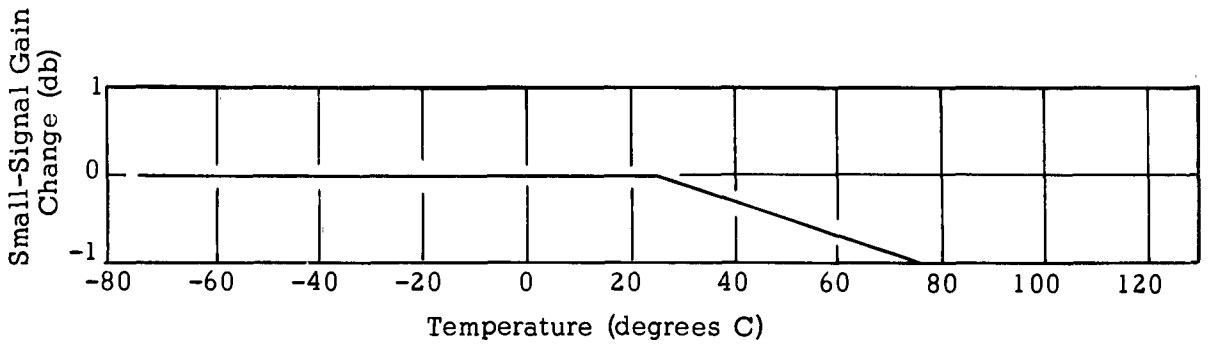
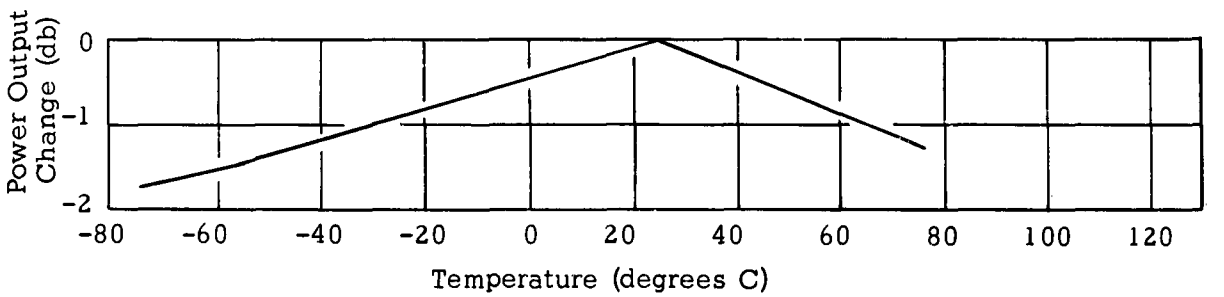


Fig. 2.2 Helix Current Versus Helix Voltage, M5057, Serial 5.

TEMPERATURE TEST PERFORMANCE, M5057, SERIAL 5

Data Taken at 3.0 Gc
Data Plotted Relative to Performance at 25C
Small-Signal Gain = 36 db
Power Output = 13.2 dbm
Noise Figure = 9.0 db





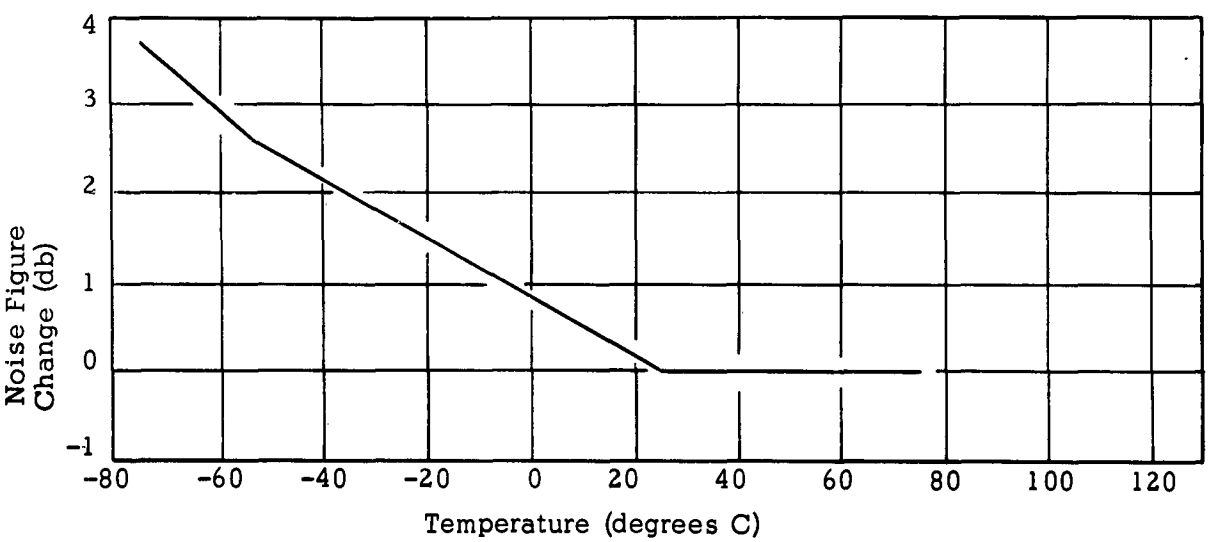


Fig. 3. Temperature Test Performance, M5057, Serial 5.

HELIX CURRENT VERSUS HELIX VOLTAGE, M5057, SERIAL 6

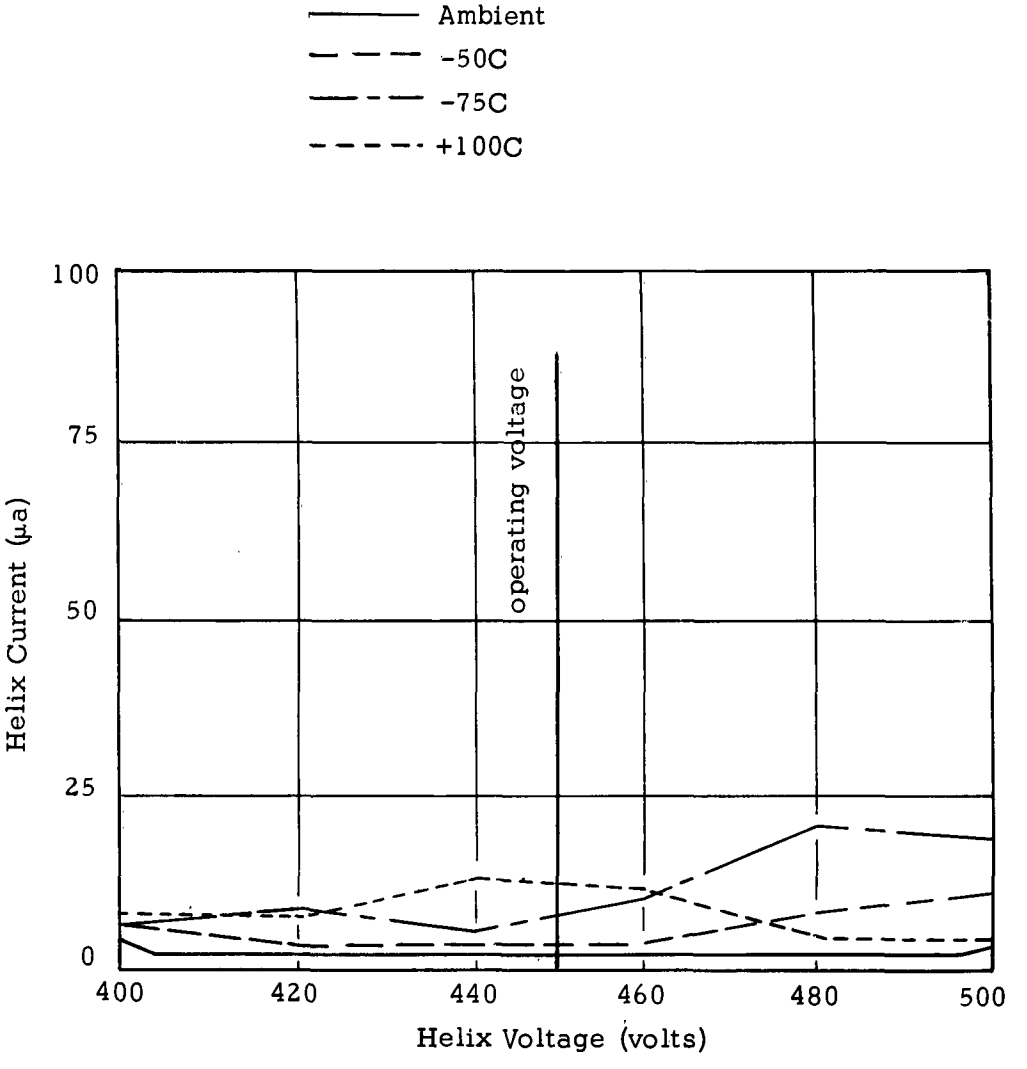


Fig. 4. Helix Current Versus Helix Voltage, M5057, Serial 6.

TEMPERATURE TEST PERFORMANCE, M5057, SERIAL 6

Data Taken at 3.0 Gc
Data Plotted Relative to Performance at 25C
Small-Signal Gain = 40.5 db
Power Output = 14.8 dbm
Noise Figure = 7.7 db

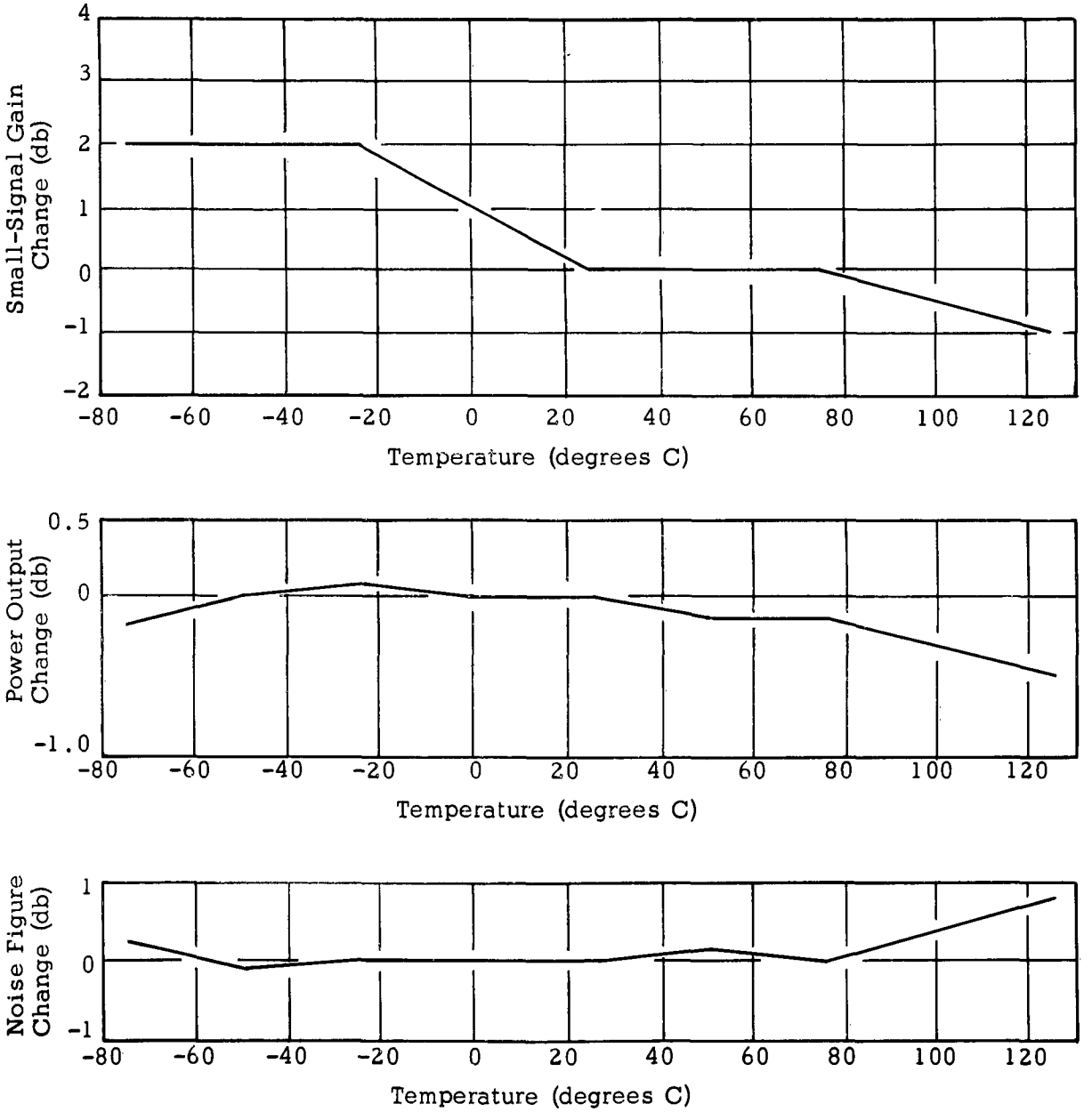


Fig. 5. Temperature Test Performance, M5057, Serial 6

40 to 55 cps in the X- and Y-axes. At 700 to 850 cps and 10 g in the same axes, the amplitude modulation was 3 to 4 db. The AM was much less than 0.5 db in the Z-axis at 0.060 DA from 5.55 cps and at 10 g from 55 cps to 2000 cps. Tests indicated that the problem was within the vacuum envelope, but the exact cause of failure is not yet known.

4. CONCLUSIONS

4.1 The primary importance of good focusing characteristics of a PPM-focused TWT, as indicated by the lack of dependency of helix current on helix voltage, has been further substantiated through the work done during the reporting period. The direct benefits of obtaining better focusing characteristics have been to realize lower noise figures at room ambient temperature and to maintain performance with little degradation over a wide range of temperatures.

5. PROGRAM FOR THE NEXT PERIOD

5.1 M5056 Environmentalization

5.1.1 Work will be continued to obtain proper focusing characteristics through both theoretical and experimental approaches. A theoretical review of the problems associated with focusing of low-voltage tubes will be made.

5.2 M5057 Environmentalization

5.2.1 Environmentalization of the M5057 should be completed during the next period.

5.2.2 Assembly will be started for the ten sets of package parts scheduled for delivery during the period. The known problems with the tubes will not affect the preliminary package assembly.

5.3 M5058 Environmentalization

5.3.1 Preliminary design for M5058 using pin matches will be completed, and vacuum envelope and package parts will be ordered.

5.4 M5059 Environmentalization

5.4.1 Completion of the M5059 environmentalization is dependent upon repeating the focusing characteristics of M5059, Serial 1, as it was in the preliminary package configuration. The better understanding of the focusing requirements obtained during the present reporting period should mean that the environmentalization will be completed during the next period.

5.4.2 Assembly will be started on the ten sets of package parts scheduled for delivery during the period.

5.5 Program Schedule

5.5.1 The program schedule is given in Fig. 6.

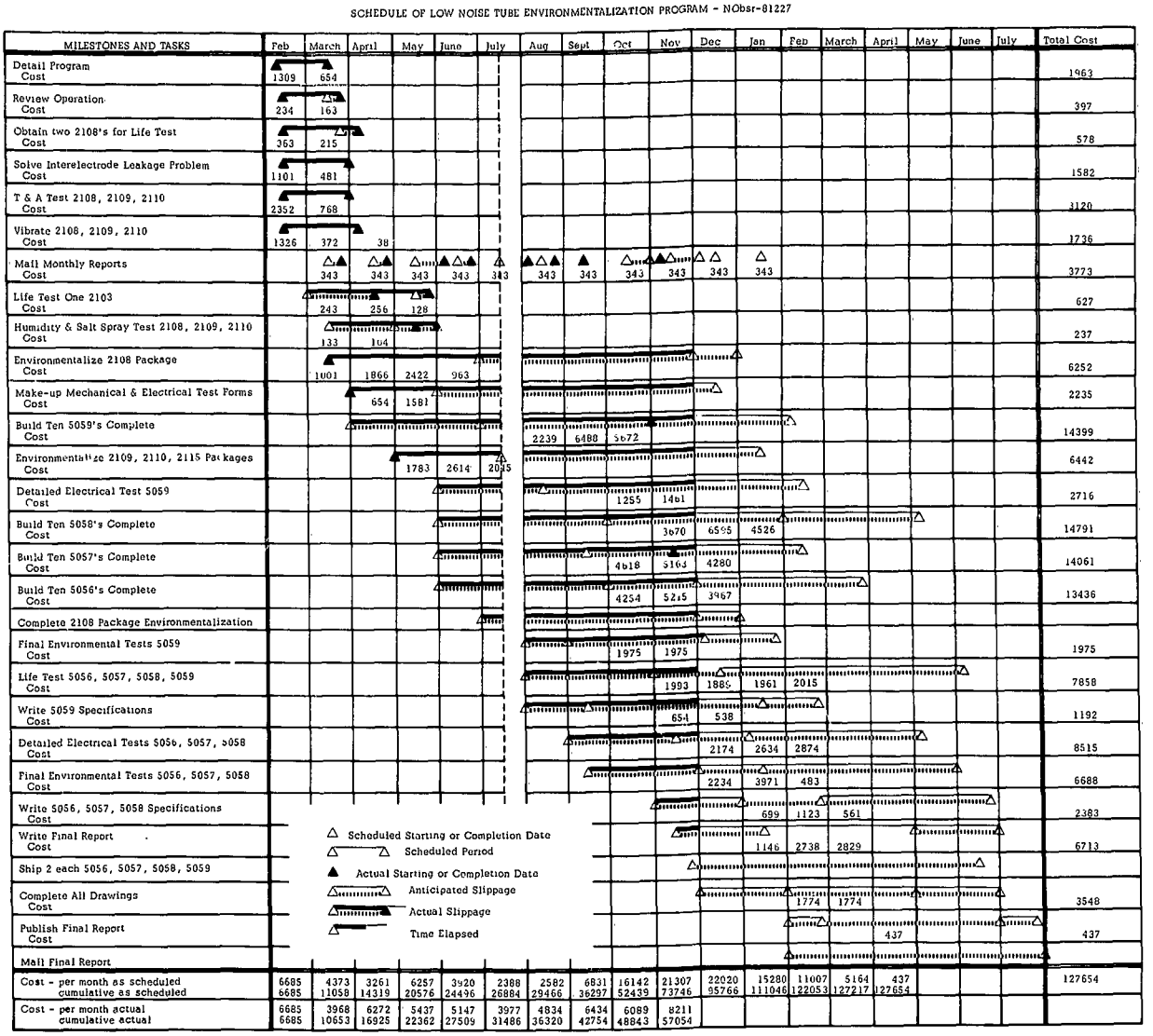


Fig. 6. Program schedule.